

Tele Vue's Big Paracorr Type-2

Designed for a small corner of the astrophotography market, this coma corrector has extraordinary potential.

Tele Vue Big Paracorr Type-2

US price: \$1,095, televue.com

Tele Vue's Big Paracorr was key to transforming the author's 12-inch f/5 Newtonian reflector into a first-class optical system used for the astrophotography with this review. The image above of the grand spiral galaxy M33 was assembled from 40-minute exposures through red, green, and blue filters with a CCD camera fitted with a KAF-16803 chip. All color astrophotographs with this review were processed by the author's colleague Sean Walker.

ALL PHOTOS BY THE AUTHOR

WHAT WE LIKE:

- Extraordinary coma correction for fast Newtonian reflectors
- Excellent coverage of large-format CCD chips
- The potential to make top-notch astrophotography more affordable

WHAT WE DON'T LIKE:

- It is currently of interest mainly to do-it-yourselfers



DURING MY YEARS of testing astronomy equipment, I've worked with some of the world's finest telescopes designed for astrophotography. (And feel free to substitute the word "expensive" for "finest" in that sentence, if you'd like.) I've used telescopes made by Officina Stellare, PlaneWave, Takahashi, and Tele Vue, as well as top-of-the-line equipment from Celestron, Meade, Star-Viewer, Stellarvue, and others. The astrophotos with this review, however, weren't made with any of them. Rather, they were taken with a 12-inch Meade LightBridge Dobsonian that I bought used for \$500. All I did was add Tele Vue's new Big Paracorr Type-2 coma corrector to the scope and, voilà, I had imaging performance that was on par with the best astrographs I've tested.

The devil, they say, is in the details, and there are definitely some between "add Tele Vue's Big Paracorr" and "voilà." The most significant involve fitting the telescope with a 3-inch focuser that would accept the Big Paracorr and attaching the tube assembly to an equatorial mount suited for astrophotography. I also upgraded the scope's secondary mirror to a larger one that provided better field illumination for imaging. Except for this mirror, I made all the parts for these modifications, but they could have easily been done with parts available commercially. I'll come back to this scope later, but for now let's look at the real reason I could turn a onetime Dobsonian reflector into a world-class astrograph — the Big Paracorr.

Why a Coma Corrector

At the close of the 19th century, photographic plates were replacing the eye as astronomy's workhorse detector. Telescopes were essentially becoming giant camera lenses, and the never-ending quest for bigger telescopes shifted from refractors to reflectors having parabolic primary mirrors — a trend that culminated with the completion of the 200-inch (5.1-meter) Hale Telescope in the late 1940s. Parabolic mirrors are also at the heart of Newtonian reflectors familiar to all amateur astronomers today even if we hear the name Dobsonian (derived from the style of mounting) more often than Newtonian.



Tight star images and fine resolution are possible with the Big Paracorr as apparent in this image of the globular cluster M15 assembled from sets of 12 1-minute exposures made through red, green, and blue filters.

Newtonians with parabolic primaries have many advantages, but they suffer from coma. This inherent optical aberration distorts stars into seagull-like flares that grow larger as they appear farther from the center of the telescope's field of view. Visual observers tolerate coma by moving objects to the center of the eyepiece field where images appear sharp. But coma is a curse for astrophotographers striving to capture pinpoint stars across big fields. The problem becomes worse as the imaging detector grows larger, and it grows worse for mirrors having shorter focal ratios (lower f/numbers), which are desirable for astrophotography. This holds true regardless of the mirror's aperture. For example, any f/3.3 parabolic mirror (the focal ratio of the primary in the 200-inch Hale Telescope) produces acceptable star images across a field less than half an inch in diameter. Fortunately, wider fields are possible if a multi-element, coma-correcting lens is introduced near the telescope's focal plane.



Designed mainly for astrophotographers, the Big Paracorr has optional spacers and adapters to couple it with many DSLR and astronomical CCD cameras. But there is also an optional adjustable top that allows the corrector to be used visually with a wide range of Tele Vue eyepieces.



The author's first images with the Big Paracorr were with a 16-inch $f/3.2$ parabolic mirror mounted in a plywood tube that he made years earlier to test other coma correctors. The "first-light" image here is an uncalibrated 10-second exposure of the star field around Polaris showing pinpoint stars across the frame of the large-format KAF-16803 CCD. Some vignetting is apparent in the corners of the frame, but the shadowing at left is due to the Paracorr extending into the setup's light path, an unavoidable artifact of the tube's layout.

Yerkes Observatory astronomer Frank E. Ross was America's foremost astronomical lens designer in the early 20th century. He developed some of the first coma correctors, including ones for the 200-inch telescope that gave well-corrected fields about 3 inches in diameter. Later correctors designed by Charles G. Wynne provided even larger fields.

Commercial coma correctors for amateur astronomers have come and gone over the years, and a handful exist today that are designed for telescopes with 2-inch focusers. Some are made for visual observers, some for

astrophotographers, and some for both. I've tested several, including one a few years ago that prompted me to build an 8-inch $f/3.3$ Newtonian for astrophotography with DSLR cameras having APS-size sensors. The results were acceptable enough for me to start work on a 12-inch $f/4$ Newtonian, but I stopped after upgrading my astronomical CCD camera and DSLRs to models with sensors that were too big for the field coverage of the coma corrector.

Until Tele Vue introduced its Big Paracorr Type-2, the only current source of coma correctors capable of adequately covering large-format detectors such as the popular KAF-16803 CCD from ON Semiconductor (formerly Truesense Imaging, which was formerly Kodak) was AstroSystems Austria (ASA). Like the Big Paracorr, even ASA's smallest corrector, which is based on a Wynne design, needs a 3-inch focuser.

Enter the Big Paracorr Type-2

Building on the success of the 2-inch Paracorr Type-2 (one of this magazine's Hot Product picks for 2011), Tele Vue's Paul Dellechiaie designed the 3-inch Big Paracorr Type-2 for use with CCDs as large as the KAF-16803 and parabolic mirrors as fast as $f/3$. It was introduced at last year's Northeast Astronomy Forum in April, and a few months later I borrowed one of the first production models for testing.

The Big Paracorr has an extremely generous 80 millimeters of back focus (a third more than ASA's correctors), allowing ample room for attaching all the astronomical CCD cameras and filter wheels that I'm familiar with, as well as all DSLRs. In many cases there is even enough back focus with the Big Paracorr to squeeze in a low-profile off-axis guider.

The Big Paracorr moves the telescope's original focal plane outward a bit more than 72 millimeters (an engineering drawing showing all the relevant spacings is available on Tele Vue's website). As with the coma correctors that Ross designed for the 200-inch telescope, the Big Paracorr slightly increases a telescope's effective focal length, with a corresponding increase in f /ratio. For the Big Paracorr this magnification increase is 1.15 \times , meaning that an $f/3$ mirror effectively becomes an $f/3.45$ imaging system.

Were it not for my experiments with coma correctors in the past, the Big Paracorr would have been a challenging product to test given the rarity of fast Newtonians with 3-inch focusers, not to mention ones set up for long-exposure imaging. But I had a 16-inch $f/3.2$ parabolic mirror configured as a Newtonian in a plywood "tube," albeit one that wasn't intended for an equatorial mount. Nevertheless, I modified its focuser to accommodate the 3-inch Paracorr and simply propped up the tube in my driveway so I could shoot the field around Polaris where the sky's slow diurnal movement allowed minute-long exposures with minimal star trailing.

My first exposures with a CCD camera having a KAF-16803 CCD were remarkable. Despite the crudeness of the

setup, the Big Paracorr yielded perfectly round, virtually pinpoint stars across the frame. Vignetting was minimal in all but the very corners, and there was no discernible change in focus for exposures made through clear, red, green, and blue filters.

Plans immediately began swirling in my head for turning the 16-inch into a telescope for astrophotography, but a much faster way to test the Paracorr for long-exposure imaging was to modify my old 12-inch LightBridge Dobsonian. While I did this as a temporary test

Long-exposure tests were done with the Big Paracorr fitted to a 12-inch Meade LightBridge reflector that is described in the text. The scope's pedigree is apparent during a "photo op" the day it was attached to a Paramount ME II (reviewed in the September 2014 issue, page 38). In practice, however, the scope was wrapped in a light shroud and fitted with a tube extension that prevented stray light from reaching the Paracorr's front lens located just inside the wall of the telescope's tube. The working setup towered over the author who is nearly 6 foot 4 inches (193 cm) tall.



Visit is.gd/Pacacorr to see more of the author's images made with the Paracorr.



Despite the Big Paracorr's lenses being relatively near the telescope's focal plane, exposures are remarkably free of ghost images and halos even when very bright stars are in the field. This 30-minute shot of the Pleiades was through a blue filter.



Some long-exposure tests with the 12-inch reflector and Big Paracorr were with a CCD camera having a KAF-8300 chip. Because this CCD is smaller than the KAF-16803, vignetting is insignificant, and this view of the sinuous nebula VDB 142 in Cepheus was processed without a flat-field calibration.



Full-resolution images (left and right) cut from the corners of an uncalibrated 1-minute exposure of the Pleiades (center) made with a KAF-16803 CCD show the quality of the star images as well as the darkening caused by vignetting at the very corners of the chip. From corner to corner the KAF-16803 covers an imaging circle spanning 52 millimeters.

setup, in hindsight it wouldn't be a crazy idea to consider a LightBridge fitted with the Big Paracorr as a permanent astrophotograph from the outset. This isn't a story about telescope making, so I'll skip the details, but it's worth noting that modifications costing me less than \$200 (\$165 of which was for the 4-inch secondary mirror from Agena AstroProducts, agenaastro.com), produced a telescope that made the images accompanying this review. It's something I certainly think about when I compare my results with those I've obtained while testing commercial astrophotographs priced well north of \$10,000.

Notes from the Field

As mentioned above, I don't know of any commercially available big Newtonians that have fast f/r ratios and are made for long-exposure astrophotography. So there's no way for me to address how the Big Paracorr will perform with specific telescopes people are going to use it with (which is another way of saying that, for now, deep-sky astrophotography with the Big Paracorr is mainly in the hands of do-it-yourselfers). That said, my field notes will still be of interest to people considering the Big Paracorr for imaging.

The filtered exposures used to assemble the color images with this story were all done with a fixed focus — I did not refocus the telescope when switching between filters. I simply set my initial focus shooting through the green filter. I could, however, obtain ever-so-slightly tighter star images for the red and blue filters by tweaking the focus. In a perfect world I might have done that, but in the practical world I found it unnecessary.

Because my test setups were only meant to be temporary, I cut a few corners when modifying the tube assemblies for the 16- and 12-inch mirrors. As such my cameras ended up never being perfectly square to the scopes' optical axes. And while I could achieve good optical collimating, it too was never perfect in either setup. Regardless, I performed various tests that proved to me the Big Paracorr can form nice, tight, round star images across the full frame of a KAF-16803 CCD. Close examination of images showed that the first sign of degraded focus was a tiny elongation of star images (which mimicked poor guiding) followed by the expected bloating of stars as the focus became worse.

There is little question that I'm excited by the potential of the Big Paracorr. It clearly raises the imaging performance of humble Newtonian reflectors with fast primary mirrors to a level that can compete with today's elite astrophotographs having exotic optical designs. And it also opens up a world of possibilities for "old-school" astrophotographers like me who got started in this hobby because we could build (and afford) the telescopes we used. ♦

Dennis di Cicco has been writing about equipment in the pages of Sky & Telescope for more than 40 years.